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NOTES ON THE GEOLOGY OF THE COAST BETWEEN THE FISH AND JUJA RIVERS, SOUTH AFRICA.—By GEORGE McKAY (communicated by JOHN G. GAMBLE, M.A.).

[Read 1884, March 26.]

Part I., Igneous Rocks.

Though the writer proposes to deal with the surface or newer geographical features only, it will be necessary—in order that he may clearly carry the reader with him—to run rapidly over some of the older formations that have an important bearing on their successors. In this paper, therefore, the writer devotes his remarks exclusively to one class of rocks, viz., the igneous; reserving to another time the consideration of the sedimentary formations and the superficial accumulations.

Every one acquainted with the geology of South Africa is aware of the very remarkable formation known as the "trap conglomerate," which, shewing itself on the east coast between the 33rd and 34th degrees of south latitude, trends in a westerly direction for hundreds of miles, till it turns north and becomes lost among the metamorphic rocks of Namaqualand, everywhere maintaining a character so uniform and peculiar as to make its recognition an easy matter to any one acquainted with the subject. The formation is also important from the fact that it marks the northern boundary of the palæroic rocks in the southern part of the Colony. For these reasons it has been selected as the starting point of this paper.

The principal band (there are several) of the trap conglomerate is well seen at Stalwart Point, near the Fish River, where it forms the eastern horn of Waterloo Bay. This shallow inlet owes its formation to the greater endurance of the "trap conglomerate" and the angle which it presents to the great swell of the southern ocean. A reference to the maps will show that most of the igneous rocks form small promontories on the coast. It is not intended to enter on the difficulties that surround a satisfactory solution of how the trap conglomerate was formed. In the following remarks the reader is supposed to be travelling eastward from Stalwart Point along the coast between high and low water marks—the position most favourable for ascertaining the nature of the rocks travelled over. On arriving near the mouth of the Bequa River he will find another, though much smaller, band of trap conglomerate. It forms what is called the "Madagascar Reef" on maps. Whatever difficulties there may be in accounting for the peculiar contents of the trap conglomerate, if they be assumed to be intrusive rocks—and the objections are admittedly great—there can be little doubt that the band that forms Madagascar Reef is an intrusive rock like an ordinary trap dyke.

Between Madagascar Reef and the Keiskamma River occurs the most southerly dolorite rock known in the colony—marked No 1 on map 2. In the Western Province the most southerly that is known is about five miles to the south of Sutherland, in the division of Fraserburg; there it partakes more of a syenitic greenstone than of a dolorite. It would be a matter of considerable interest to ascertain if dyke No 1 and that at Sutherland have any connection with each other. The direction is the same in both cases—10 deg. north of true west. To observers who travel by railway and take an interest in these matters, I would recommend the following points for examination :—

1st—On the Beaufort West Railway—about ten miles north of Beaufort West.

2nd—Near the Bull River, Zwart Ruggens, on the Graaff-Reinet Railway

3rd—At the Little Fish River on the Cradock Railway.

Between the Keiskamma and Chalumna Rivers and at Payne's Drift, at points marked by a cross on map 2, are bare patches of a peculiar jaspery conglomerate containing pebbles of wood-opal, calcedony, and other rounded fragments of foreign rock, set in a matrix of liver-coloured jasper. The conditions of this rock have not been satisfactorily ascertained; but it is highly possible that it has been an over-spreading mass of molten matter that has flowed over the dicynodon rocks while they were in process of deposition. This would, of course, make it older than the overlying shales and the subsequently intrusive traps. The three points marked × on the map are nearly on one level, and doubtless form one continuous sheet, probably an outflow from the neighbourhood of Mount Coke, where an inextricable complication of almost every variety of erupted rocks occurs. Part of the complication there may arise from the intersection of dykes Nos. 4, 5, 6, 7, 8, 9, 10, 11 and 12. In addition to this, however, it is inferred from the beds of laterite found that it must have been the centre of a more recent and independent heat action. As it would be impossible to indicate even a remotely accurate delineation of the rocks here without an expenditure of time and labour that is not at the command of the writer, the space it should occupy on the accompanying map has been left blank. Mount Elizabeth—one of the three cone-like hills which form what is known as the district of Mount Coke, is a core-like mass of trachyte, is more recent and quite unconnected with the bewildering numbers of trap-dykes by which it is surrounded. At Fort Grey, near East London, and at the Quintani in the Transkei, bosses of a similar trachyte occur under the same conditions.

Dyke No. 8 is a very beautiful porphyry, about 15 feet wide, of a dark reddish-brown colour with crystals of pearly felspar, about a quarter of an inch square, very regularly distributed through it. It will, at some future day, be a stone of considerable value for architectural purposes.

About two miles to the south of dyke No. 15, and near Peelton, a dyke crops up, the strike of which I have not been able to determine. It is composed of albite and hornblende, and is probably connected with a dyke that occurs at the Izeli (King Williamstown division, beyond the range of map 2). It is mentioned here to note its peculiarities in weathering, being galleried and caverned in all directions into the most fantastic shapes. (A specimen was sent to me from the Izeli as a huge fossil human pelvis, to which it bore a very strong resemblance). This peculiarity of weathering is due to the comparatively speedy dissolution of the soda contained in the albite, under the influence of damp and moisture. Every change of wind lodges dust in some crevice or irregularity of surface; this dust retains the moisture, which, acting on the soda, corrodes it into a pit which may continue to deepen till it meets a similarly formed pit from another direction; or a change of wind may lodge dust in another position in the enlarged pit, causing galleries within galleries, and as this goes on at all angles that dust can be collected or moisture retained, the results are more easily imagined than described in words.

Dyke No. 31 is a large dyke of orthoclase with brush-like diverging tufts of hornblende distributed through it. This dyke forms a very striking feature in the landscape. Looking to eastward from the heights above the Kei on the east side, it presents the appearance of a deep depression on the surface, running in a perfectly straight line through hill and valley without interfering with the general surface drainage of the land, which follows its shortest course to the sea, crossing the dyke at an angle of about 40°. It is marked on our best maps as the "Transkei Gap," with the note "probably caused by an earthquake." The explanation of this singular appearance is very simple. The felspar of which the dyke is principally composed decomposes more rapidly than the adjoining stratified rocks, and permits of greater wear and tear along the line occupied by the dyke.

A similar depression, occupied by a dyke largely composed of potash-felspar, occurs a little to the south of Cathcart, and may possibly be a continuation of dyke No. 31.

The crowding of the dykes where my opportunities of observing have been greatest (in the neighbourhood of East London and on a line from the mouth of the Gonubie River to the Kei Bridge) warns me that I have not exhausted their number, and that others may exist that have escaped my observation. Of the 34 numbered in the space of 100 miles, only two of them (Nos. 33 and 34) deviate from the (roughly) east and west direction taken by the other 32 dykes. This they do to the extent of 30 deg. They are singularly parallel to each other, and have the same appearance and mineral composition—a coarse-grained dolorite, which yields a large amount of titantic iron in minute crystals on decomposition. They are newer than the other 32 dykes. No. 34 has been traced through Nos. 9, 8, 7, 6, and 5 without suffering alteration. No. 33 cuts through Nos. 26, 25, and 22. This dyke will be easily recognised as the road passes over in the direction of its length from Draaibosch to the Komgha, and in cutting in the road on the west side leading to the Kei, and about a mile from the bridge, it intersects the centre of the larger dyke No. 26, and presents so marked a difference to the adjoining rocks as to arrest the attention of any one at all observant.

A rapid *en passant* notice of these erupted rocks does not permit of minute details. And as all geological correctness is a work of very gradual approximation and very extended research, it would be out of place here to enter into any, based as they would be on a comparatively narrow range of observation. But as little or nothing is known of the trap rocks in the Karroo districts of the colony, I am encouraged to offer what have suggested themselves to me as the salient points connected with them, with the hope of receiving corroboration or correction from other observers.

1st. They are more recent than the Dicynodon Beds (Lower Triassic of Europe).

2nd. They do not occur to the south of the line of trap conglomerate.

3rd Their numbers are very great (in the proportion of one to every three miles of lineal space).

4th. They traverse great distances (hundreds of miles) in a perfectly straight line, have a remarkable parallelism to each other, and are of a magnitude unprecedented in any record that has come within my knowledge. Most of the works that I am acquainted with treat the subject incidentally, and I know of no attempt to trace a dyke to its termination. They are usually treated as emanations from some centre in their immediate neighbourhood, or regarded as mere veins. Though beyond the range of the accompanying plans, I will here note my attempt to trace a dyke over a very considerable space of ground. This may for convenience be called the " Spitzkop Dyke."

(a) Between three and four miles north of the Bashee river mouth there is a large dyke of dolerite. A scrubby bush growing on loose sand approaches down to high water mark, and obstructs a view of the direction of the dyke.

(b) But seven miles from the sea shore a dyke similar in mineral composition crosses the Bashee just above the lowest bridle drift. It is there nearly vertical, and has a trend of 37 deg. west of magnetic north—or corrected for variation 8 deg. north of true west.

(c) Close to Txakxa—a mission station in the Idutchywa Reserve, in the Transkei—there is a similar dyke trending 37 deg. west of magnetic north.

(d) A dyke traversing the Xolosa mountain—between the Tsomo and the Kei Rivers—has precisely the same trend. From the top of this mountain an uninterrupted view eight miles long can be had of this dyke.

(e) About two miles south of St. Mark's—there is a dyke of dolerite trending 37 deg. west of magnetic north.

(f) The Queenstown railway crosses a dyke at nearly right angles one and a-half miles beyond (north) Tylden.

The foregoing six points are from personal observation. In extension of this, a dyke that passes through or close to the town of Tarkastad is described as having a north-east and south-west direction.

(g) The summit of the Doornberg, in the division of Cradock, is cut through by a dyke, but up to date I have not been able to learn the direction it takes.

(h) The Spitzkop of the Compass Berg, in the division of Graaff-Reinet, was ascended by Wyley in 1857. He describes the dyke that intersects the peak as cutting the perpendicular south-west face at an angle of 50°. This description, though not as precise as could be desired, leaves little doubt that the dyke there takes the same general direction as the other points, that have their trends fixed, do. Now if the reader will plot these points on a fairly good map, it will afford a strong presumption that the Spitzkop dyke forms one continuous and direct line to the Bashee mouth, a distance of upwards of 260 miles.

5th—The dykes do not interleave or intrude themselves horizontally into the stratified rocks they pass through till they reach an elevation of upwards of 2,500 feet above the present sea level. Above this height, in many places they have thrust themselves horizontally between the strata at different levels—where they form extensive sheets—protecting those portions of stratified rocks covered by them from rapid denudation, and causing the form of many of our tea-caddy and table-shaped mountains seen in the divisions of Queenstown, Cradock, and the Tarka. And absence of these horizontal beds in the lower regions has produced the clustered hummock-like and rounded outlines that form so distinctive a feature of the country lying below the 2,500 feet level.

6th—They have caused very little disturbance or displacement in the stratified rocks, through which they have forced their way—a fact of some importance which may be of value in determining the conditions under which the dykes were formed. The corrugations seen in the section on plate or map 3 are the results of a lateral compression, subsequent to the formation of the dykes. The greatest disturbance that I have observed (within the range of the maps) occurs at dyke No. 29, between the Kei Bridge and Toleni. A cutting in the new road gives a good section of the stratified rocks and this dyke, which is here about 70 feet wide. The south side of the stratified rock is not disturbed; on the north side it is tilted about 30°, and this shades off into the general bedding of 5° N.W. at 200 yards from the dyke. In Griqualand East, however, a tilting up of 70° in a ripple-marked shale has been observed near Ficani's Kraal, on the Umzimkulu river.

7th.—That though the smaller dykes (100 feet and under in width) are sufficiently homogeneous to be comprehended under one term, as dolorite, diorite, &c., as the case may be. the same does not hold good with respect to the larger dykes, some of which are upwards of a mile in width. In the larger ones every variety of erupted trap (not vesicular or amygdaloida) may be seen, shading gradually off into each other, so that it is impossible to point out where one begins or the other ends. In illustrating this I will particularly refer to dyke No. 9, being the one which my opportunities of studying have been greatest, having had the platform between high and low water marks laid out like a map before me daily for a great number of years. The eastern edge of this great dyke consists of a coarse rough trachyte, light coloured, with glassy felspar. At 100 ft. to westward this passes insensibly into a dark hornblendic rock with crystals of albite. This is the only portion of the dyke that decomposes into globular masses and concentric layers with a solid kernel—the so-frequently mentioned but never-explained cheeses, cannon balls, &c., of authors. The concentric layers are studded with hexagonal plates of a bright yellow-coloured mica 1-20th of an inch in diameter, which are not to be found in the solid kernel or in those portions of the rock not undergoing decomposition, though slices have been subjected to scrutiny by microscope. They are therefore assumed to be a secondary combination, resulting from the decomposition of the original rock. This portion of the dyke is also traversed by a multitude of parallel lines of a jet black hornblende, from the finest line to a quarter of an inch in thickness; the lines follow the general direction of the dyke, and cut clean through the crystals of felspar and hornblende which compose the rock, passing through concentric coatings quite unaltered, and forming miniature black ridges through them.

The hornblendic portion of the dyke passes gradually into a very compact and highly crystalline basalt. The basalt passes into orthoclase, which in its turn merges into a mass mainly composed of augite in coarse crystals. And these variations continue till the dyke terminates on the west side in a vertical wall of highly crystalline basalt, the beds of the adjoining stratified rocks being undisturbed, though the effects of heat are visible on east and west sides for a considerable distance Now, though there is a great probability that the hornblendic rock referred to above is a later injection into the main dyke, the conditions under which it was formed must have been peculiar, as the gradations from trachyte on the one side and basalt on the other are perfect. The same inference cannot be made with regard to the other variations in the dyke, which in many places show a tendency for the particles of a single mineral to aggregate themselves together over considerable areas, and thus increasing the difficulty of finding any name sufficiently comprehensive and yet distinctive for a dyke of this magnitude and condition.

A few broad terms in connection with erupted rocks fit for a geologist to handle in the field is a great want. Mineralogy gives no assistance ; it, of all the sciences that cluster round the broad term geology is the oldest, the most pretentious, and least satisfactory.

ON THE VARIATIONS OF LEVEL OF THE CAPE TRANSIT-CIRCLE.—By W. H. Finlay, B.A.

[Read 1884, Sept. 3.]

The Cape transit-circle was erected in 1855 and brought into regular use in 1856. From that time to the present date a continuous series of observations has been maintained for determining the instrumental adjustments.

The instrument is one of the largest of its class and is exactly similar to the Greenwich one. The piers consist of a few large blocks of very hard sandstone from a quarry near Tiger Berg, and rest on the rock; every care was taken to cement them into two solid masses. It was expected with such a strong and massive instrument that the changes in the adjustments would be very slight indeed, but this expectation was not fulfilled.

For the first three or four years the instrument was fairly steady, but from about 1860 up to the present time there have always been large and well-marked changes of position in the course of the year.

This is more especially the case with the level error, and a constant and continuous watch has consequently been kept on it.

The telescope cannot be reversed on its bearings and is not adapted for the application of an ordinary spirit level; but the level error and zero of the vertical circle (or Nadir-point reading) are determined by observing the images of the wires reflected from a trough of mercury, an observation admitting of extreme nicety and accuracy; the error of azimuth is determined by observations of polar stars.